Descriptive epidemiological analysis of diving accidents in Hawaii from 1983 to 2001

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Abstract

The Hyperbaric Treatment Center (HTC) at the University of Hawaii, has evaluated and treated over 1100 divers for dysbaric disease from 1983 to 2001. We describe some epidemiological parameters and compare trends between local residents and tourist divers in this article. Data obtained from this review were analyzed for age, gender, type of injury and resident status. While trends in Hawaii have mirrored national figures, we did determine that there were some significant differences between resident and tourist divers' patterns of injury over this period of time.

Introduction

As an island state located in the mid-Pacific Ocean, Hawaii attracts thousands of visitors each year who come to partake of the aloha spirit, the warm, balmy climate, and an amazing number of scenic wonders and activities. Scuba diving, one such activity, has been increasing in popularity as a recreational enterprise since it was introduced.

Hawaii also has many residents whose employments, as well as recreational interests involve diving. Participation in this activity exposes these divers to some unique risks as a consequence.

In 1983, in response to the growing interest in scuba diving in the islands, and the anticipated need for treatment of potential diving injuries, the State of Hawâii established the Hyperbaric Treatment Center (HTC). Since its inception through 2001, the HTC has treated over 1100 patients for dysbaric disease. Several studies describing the frequency and types of diving injuries, treatment modalities, and treatment complications in Hawaii have been conducted.[1-4] This paper will describe some of the epidemiological characteristics and parameters of the total patient population evaluated at the HTC, and compare trends between resident and tourist divers.

Methods

A retrospective chart review was conducted in 2002 on patients who presented to the HTC for suspected diving related injuries. Data obtained from this review were analyzed looking at age, gender, type of injury (AGE or DCS), site of accident, and resident status (local vs. tourist) using Microsoft Access and Excel. Graphic representation of these data were produced and subjected to trend analysis. Variables were analyzed using the chi-square test (significance level = 0.001).

Results

Over the study period, a total of 1192 patients were evaluated for potential dysbaric injury. Figure 1 depicts the number of cases seen per year. The average number of cases per year was 63. Peak injury years were from 1991 through 1996 where the average number of cases per year was 88. Male divers have represented the majority of cases each year except in 1990 and 1993, but the trend has steadily moved towards gender parity (Figure 2). Residency status was clearly defined in 1110 of these patients. Local residents constituted the majority in every year and totally (736 cases, 66%), but since 1990, tourists (374 cases, 34%) have steadily increased from 30 to 47 per cent of the caseload (Figure 3). Of the total number of 1192 patients evaluated for dysbaric disease, 866 were determined to have either an Arterial Gas Embolism (AGE) or Decompression Sickness (DCS), which required recompression treatment. The total number of AGE cases was 100 (11.5%), while the total number of DCS cases was 766 (88.5%) (Figure 4). When comparing injury type versus resident status (Table 1), there was little difference between the two groups with respect to DCS occurrence (residents- 91.7%; tourists- 83.3%), but when looking at the AGE cases, tourists suffered this disorder at twice the rate of residents (16.7% vs. 8.3% p= 0.001). Among residents, 4-5 times as many males were injured as compared to females, while in the tourist population, males constituted nearly 60% and females were just below 40% (Table 2). Female tourists had twice the injury rate of resident females (Table 2). The age for defined injury cases averaged 34.4 years (range 12-77) with most cases occurring in the 21-40 year age group (Figure 5). Since 1996, there has been a gradually increasing trend in the number of the older than 41 age group. Of note is the fact that tourists under age 20 had an injury rate double that of resident cases in the same age group (Table 3).

When evaluating site of injury, most cases originated from Oahu (49.2%), followed by Maui (23.3%) and Hawaii (15.6%). Residents were more often injured on Oahu while tourists were more often injured on Maui (Figure 6).

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Figure 1.— Distribution of cases from 1983 to 2001 (n=1192)

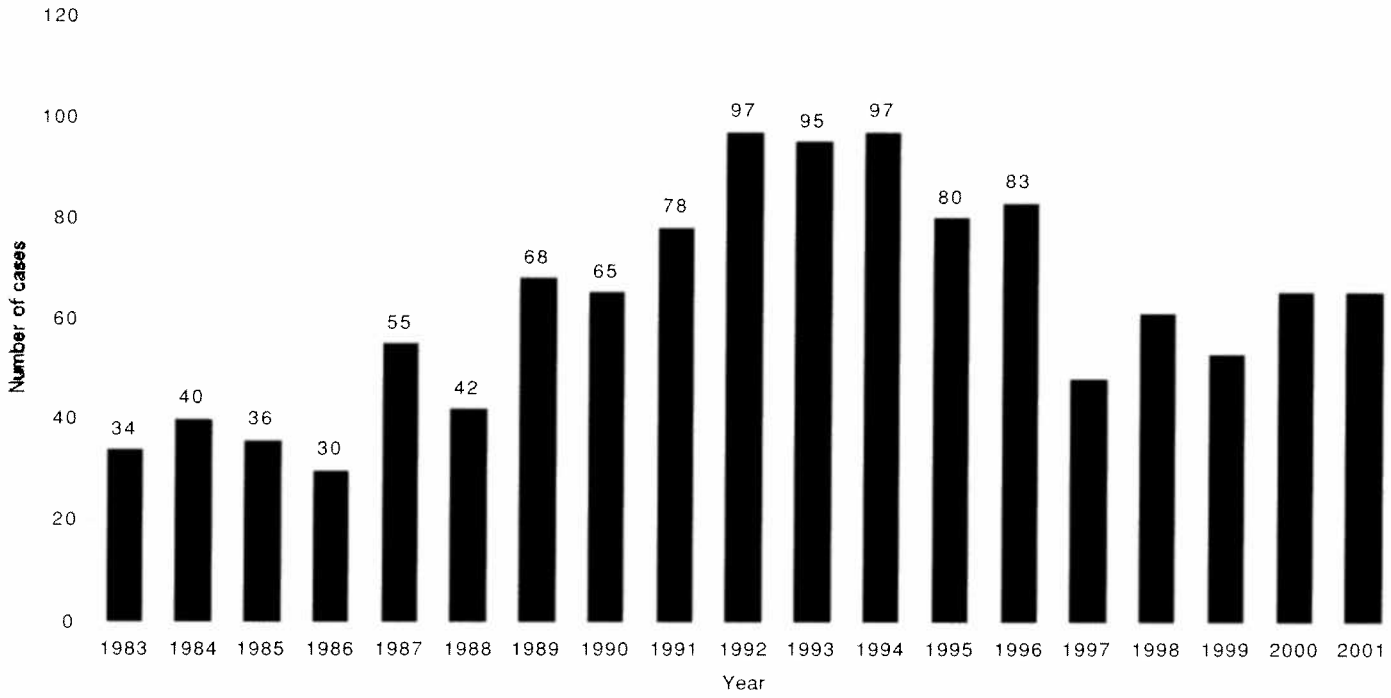

Figure 2.— Ratio of each gender cases from 1983 to 2001 (n=1192)

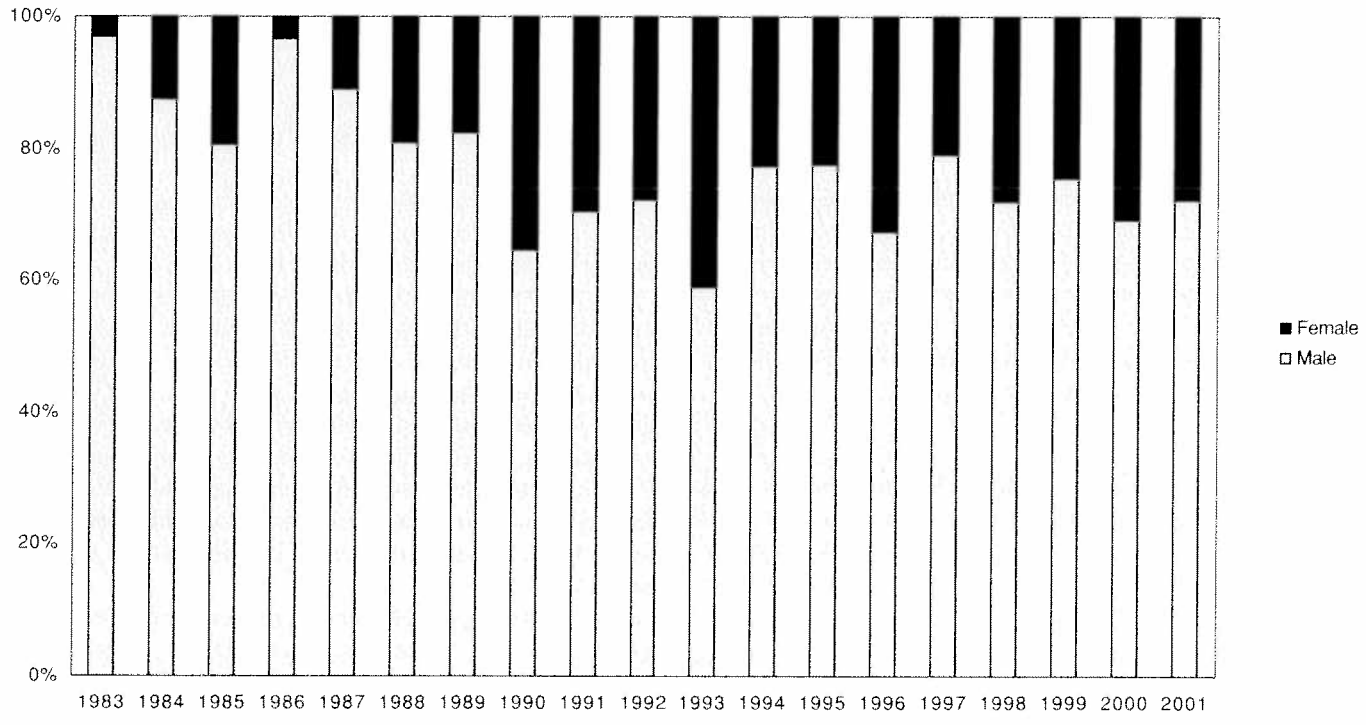

Figure 3.— Ratio of each residential status cases from 1983 to 2001 (n=1110)

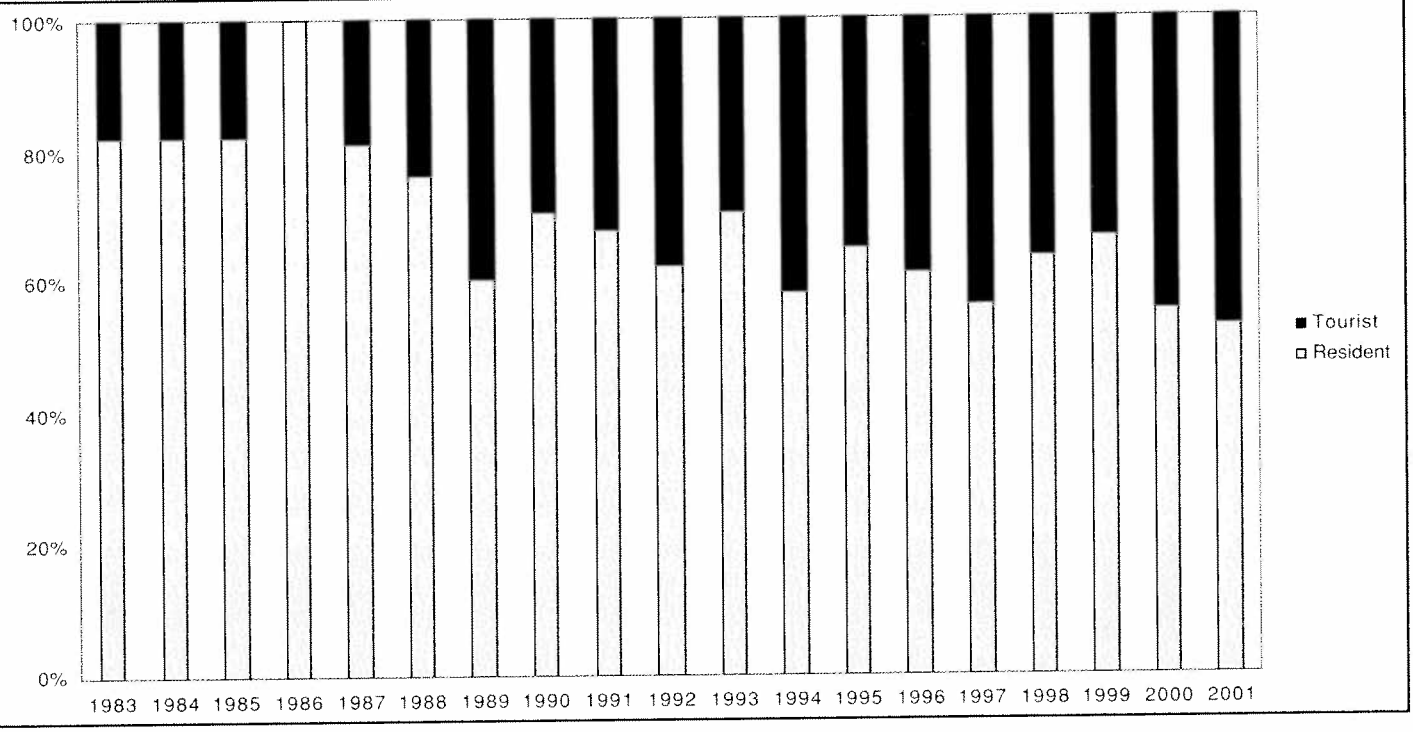

Figure 4.— Ratio of DCS cases and AGE cases from 1983 to 2001 (n=866)

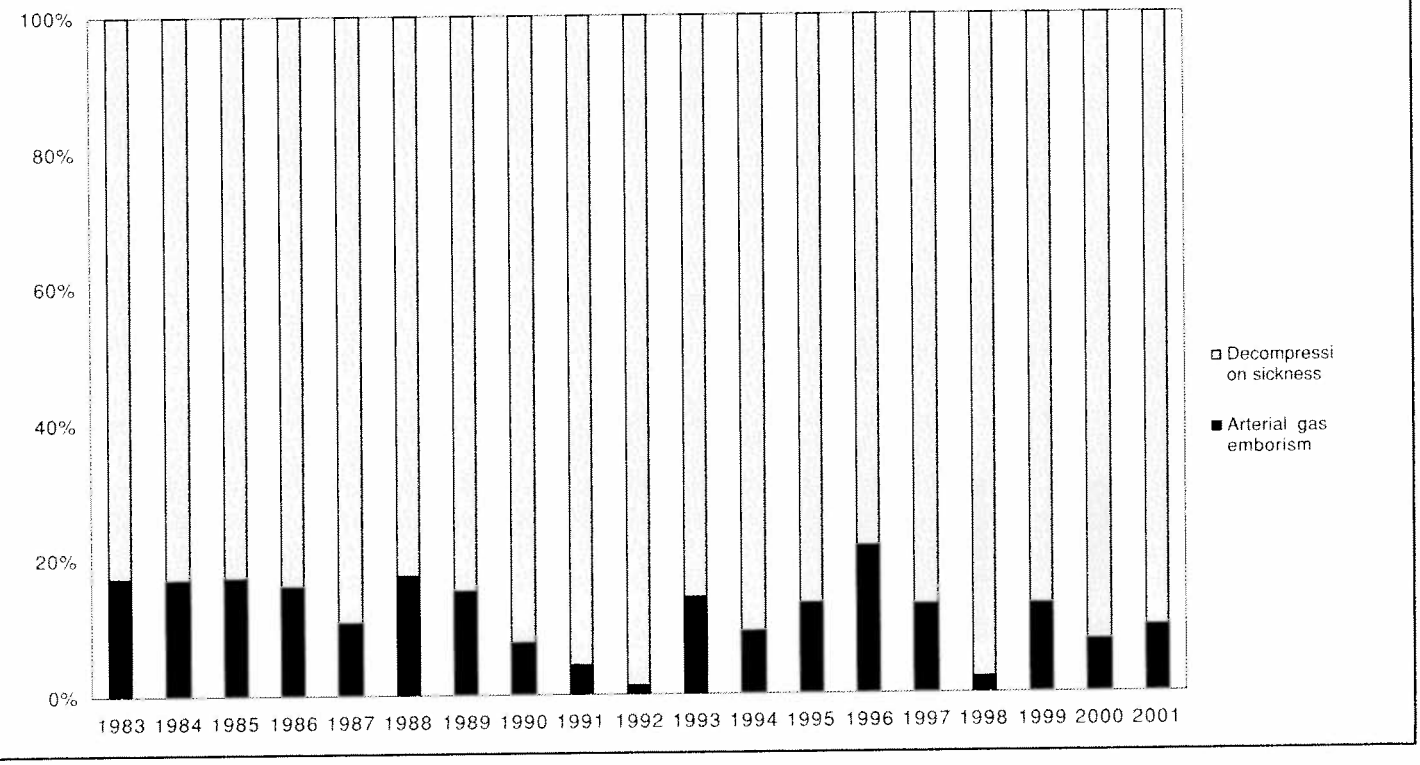

Figure 5.— Ratio of each age groups from 1983 to 2001 (n=857)

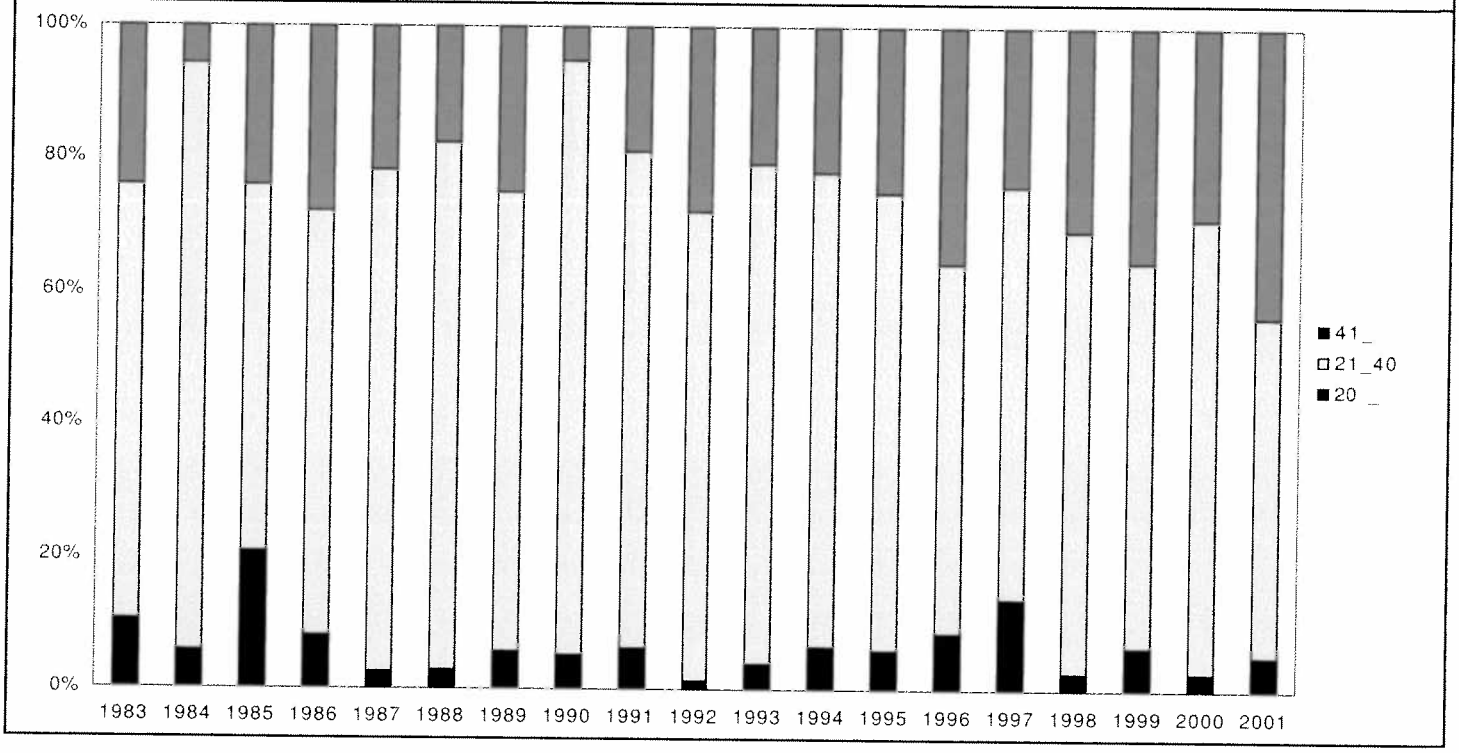

Figure 6.— Site of injury between residents and tourists (n=1009)

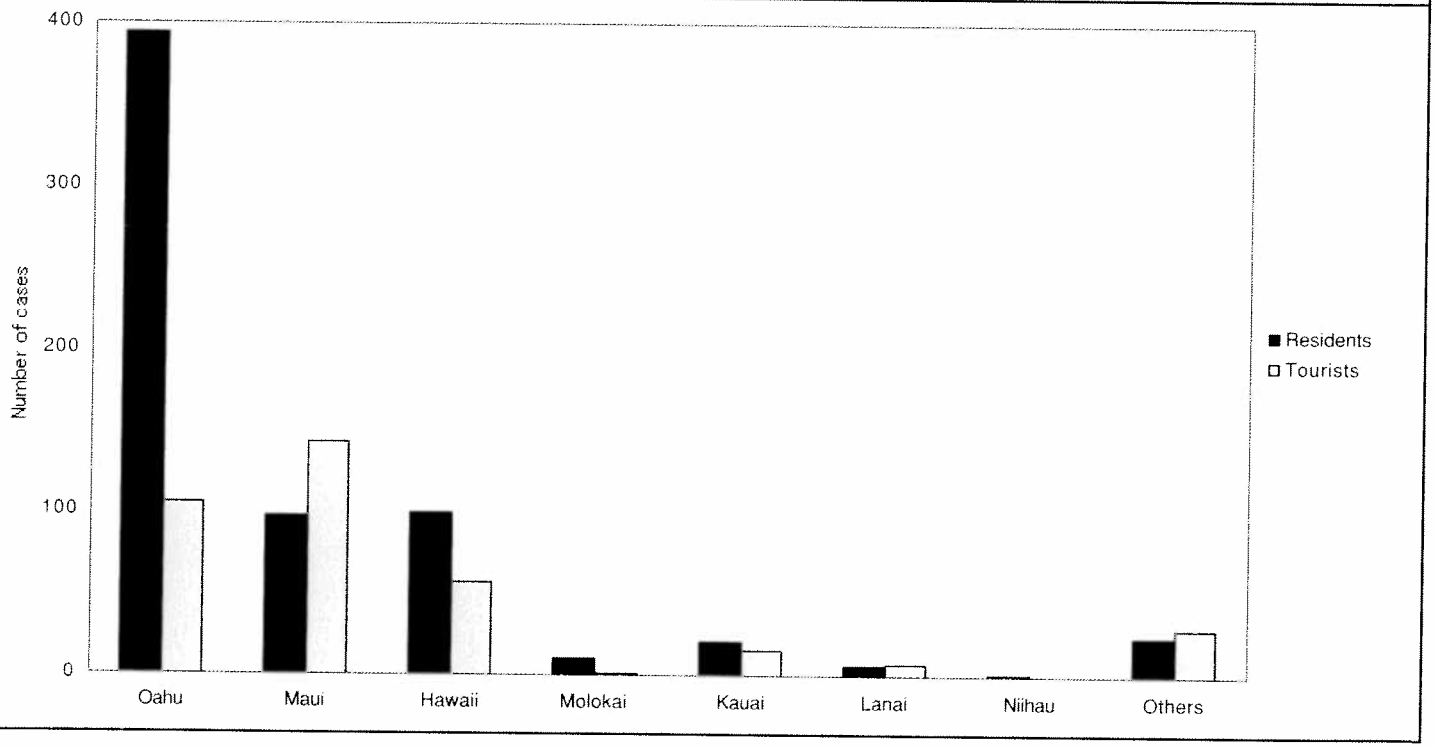

Table 1.—Comparison of injury type between residents and tourists (n=803)

	AGE		DCS		Total	
	Cases	%	**Cases**	%	**Cases**	%
Residents	46	8.3	505	91.7	551	100.0
Tourists	42	16.7*	210	83.3	252	100.0
Total	88	11.0	715	89.04	803	100.0

*$T=12.261>X^{2}_{(0.05),(1)=3.827}$

AGE : Arterial gas embolism

DCS : Decompression sickness

Table 2.—Comparison of gender of DCI cases between residents and tourists (n=803)

	Male		Female		Total	
	Cases	%	**Cases**	%	**Cases**	%
Residents	459	83.3	92	16.7	551	100.0
Tourists	154	61.1	98	38.9	252	100.0
Total	613	76.3	190	23.7	803	100.0

DCI : Decompression illness includes arterial gas embolism and decompression sickness.

Table 3.—Comparison of age groups of DCI cases between residents and tourists (n=784)

	20		21-40		41		Total	
	Cases	%	**Cases**	%	**Cases**	%	**Cases**	%
Residents	24	4.4	384	70.5	137	25.1	545	100.0
Tourists	24	9.6	162	65.1	63	25.3	249	100.0
Total	48	6.0	546	68.8	200	25.2	794	100.0

Until there's a cure, there's the American Diabetes Association.

Discussion

The Hyperbaric Treatment Center consistently ranks as the third most active treatment facility in the United States for diving injuries according to published statistics of the Divers Alert Network (DAN) located at Duke University for whom the HTC serves as the Pacific Regional Coordinator. Injury data from all reporting sites nationwide are compiled and analyzed yearly in an attempt to identify trends which may put divers at risk and to make recommendations for enhancing diving safety [5,6]. The Hyperbaric Treatment Center is the only facility providing treatment to non-military divers in the Hawaiian Islands. Thus most diving accidents that have occurred in Hawaii were treated there with the exception of military divers who were treated at Pearl Harbor, and a small number of divers who are known to have employed in-water recompression to treat themselves. Those two latter exceptions were not included in our data analysis. This study is limited by the fact that it focuses only on cases with injury that presented to the HTC. In order to determine incidence of injury, one must know the total number of dives undertaken by all divers yearly, and at the very least, in order to obtain a closer estimation of injury rate, one must know the total number of divers. This was an impossible task in either case, and thus we were circumscribed to present case-related data and analysis.

Since 1995, the total number of cases reported to DAN by the HTC has constituted 5% of the total number of cases reported nationwide [7]. Our data with respect to injury types, gender, and age distribution mirror the national trends [7]. Of special interest to us was the additional need to evaluate the relative rates of tourist injury and their locations within the state.

The overall trend in the number of cases treated at the HTC has decreased over the past 5 years. This may reflect several possibilities: fewer divers diving, safer diving practices being employed, or perhaps decreased visitation to the islands.

The age distribution in our cases was consistent with the national figures, but does show an increasing trend with older divers, which in all likelihood is constituted by aging "baby-boomers". An interesting observation was that tourists aged 20 years or less were injured at twice the rate of residents of the same age group. Due to insufficient data, we were unable to ascertain why this was the case. This could perhaps be attributed to a number of things not the least of which may be that many divers actually do their initial training here and therefore are less experienced and more susceptible to injury and/or that many tourists come as families and once here the lure of the ocean and the easy access to dive training promotes younger ages to take up scuba even though they may not be physically or mentally prepared to handle diving comfortably. Yet another concern develops when dive training is undertaken in a short period of time as is likely to be the case while on vacation, which does not allow adequate time to assimilate requisite diving knowledge [8,9].

Tourists also demonstrated higher rates of injuries in females, as well as in suffering an AGE, which is most often associated with buoyancy control problems or out of air ascents commonly seen in novice divers, and thus tends to support the previous comments regarding the younger aged cases. In an Australian study, tourists treated there were likely to dive only when they traveled and many had failed to maintain their diving skills [10]. At present, sports diving requirements do not compel divers to maintain their skills and knowledge. Moreover, diving certification cards have no expiration date. Diving after extended absence, unfamiliar dive sites, water conditions, or equipment, as well as language barriers in foreign visitors tend to increase diver stress and subsequent panic. The most common underlying cause of diving injury or death is panic [11].

With respect to site of injury, not unexpectedly most residents were injured on Oahu where the vast majority of the state's population resides. Interestingly, tourists were more apt to be injured while diving on Maui. This in large part is because diving sites there, particularly Molokini, are more pristine and offer visitors something more of a variety of diving experiences.

Conclusion

We have presented a descriptive epidemiological analysis of diving accidents treated at the Hyperbaric Treatment Center over the past 18 years. The Center continues to provide invaluable service to the state, its residents and visitors. Our patient population has been a microcosm of the nation with respect to trends in the parameters studied.

Acknowledgement

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